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Solid Waste Management Evaluation for New Hanover County, North Carolina

CSI Resource Systems, Inc.
Boston, MA

Prepared for

Environmental Protection Agency
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A TECHNICAL ASSISTANCE PROGRAM REPORT

SOLID WASTE MANAGEMENT EVALUATION FOR NEW HANOVER COUNTY, NORTH CAROLINA

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RESOURCE RECOVERY AND CONSERVATION PANELS

SEC. 2003. The Administrator shall provide teams of personnel, including Federal, State, and local employees or contractors (hereinafter referred to as "Resource Conservation and Recovery Panels") to provide States and local governments upon request with technical assistance on solid waste management, resource recovery, and resource conservation. Such teams shall include technical, marketing, financial, and institutional specialists, and the services of such teams shall be provided without charge to States or local governments.

This report has been reviewed by the Project Officer, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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This study is an analytical assessment of solid waste management options, including: transfer stations, baling, shredding, incineration, and sanitary landfills. Conclusions speak to modular incineration with and without energy recovery as the most attractive possibility for the County of New Hanover, North Carolina.

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TECHNICAL ASSISTANCE PROGRAM REPORT SERIES

SOLID WASTE MANAGEMENT EVALUATION

FOR

NEW HANOVER COUNTY, NORTH CAROLINA

PREPARED FOR
OFFICE OF SOLID WASTE MANAGEMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV, ATLANTA, GEORGIA

BY

ENGINEERING-SCIENCE, INC.
ATLANTA, GEORGIA

AND

CSI RESOURCE SYSTEMS, INC.
BOSTON, MASSACHUSETTS

JANUARY, 1981

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CHAPTER 1

EXECUTIVE SUMMARY

INTRODUCTION

New Hanover County is located in the Tidewater section of southeastern North Carolina, on the Atlantic Ocean. The county forms a peninsula which is bounded on the east and south by the Atlantic Ocean and on the west and northwest by the Cape Fear River.

The 1980 preliminary census figures report that New Hanover County has a population of 100,700 and of that population 43% resides in the City of Wilmington. In addition, the County has three (3) incorporated towns: Carolina Beach, Kure Beach and Wrightsville Beach with a combined population of 6500 people.

The coastal region has typically posed difficult problems in the past with the effective siting and the proper environmental operation of sanitary landfills. This is caused by large areas of permeable surficial sands and the relatively shallow groundwater table which tend to maximize problems associated with the formation of landfill leachate. In late 1979, the New Hanover County Commissioners requested technical assistance from the U.S. Environmental Protection Agency (EPA) Region IV in the area of solid waste management.

A Technical Assistance Panels program has been established by EPA under provisions in the Resource Conservation and Recovery Act of 1976 whereby EPA, in conjunction with selected engineering consultants, offers technical assistance to local governments to assist them in the proper management, disposal, and/or recovery of solid waste. Engineering-Science, Inc. (ES), under subcontract to CSI Resource Systems, Inc., was retained to address the following:

- Provide written comments on the Post, Buckley, Schuh, & Jurnigan (PBS&J) report(s) for New Hanover County. Management assistance shall be provided to County staff in developing a scope of activities by the present County Consultant in their projected Phase II and Phase III work.

- Investigate the need for and relative economics of using clay and artificial liners to protect the water table.

- Using available County records calculate the cost of hauling refuse to the selected site. The ton-mile costs shall be utilized to determine the relative need for transfer stations and the potential locations of transfer stations with respect to waste generation centroids.

- Using available data, determine preliminary waste quantity and quality figures for the purpose of estimating per ton costs and potential recoverable materials.

- Conduct a preliminary assessment of materials and energy recovery markets in the area to determine resource recovery potential. Existing source separation and material recovery programs shall be identified.

The City of Wilmington and the unincorporated areas of the County currently are disposing of their solid waste at the Blue Clay Road site which has been temporarily permitted by the State. The towns of Carolina and Wrightsville Beach dispose of their solid waste in a local landfill and by incineration, respectively.

Current waste generation estimates of 1990 tons per week prepared by the County's solid waste consultant, (PBS&J) were found to be higher than previously reported values as follows:

Location	COG Report Per Capita Generation Lbs/Capita/Day	PBS&J Per Capita Generation Lbs/Capita/Day
City of Wilmington	4.01	6.83
New Hanover County (less Wilmington)	3.25	4.76

Differences were attributed to the fact that industrial waste currently being disposed of in the County's landfill is included in the PBS&J figures and not in the earlier Council of Governments (COG) report. In addition weight/volume data from Wilmington indicated previous factors used to convert cubic yards to pounds were too low. Since the PBS&J report has not been issued, it was not possible to make a specific judgement regarding the individual rates.

SANITARY LANDFILL PRACTICES

Criteria utilized for the siting of sanitary landfills in the past were presented as follows:

- Zoning
- Site Geology
- Site Accessibility
- Public Acceptance
- Location away from Groundwater Supplies
- Availability of Cover Material
- Location of Airports
- Soil Permeability
- Groundwater Depth

Recent EPA proposed regulations on landfills were reviewed and their emphasis on groundwater protection cited. This regulatory emphasis will result in design engineers having to specify clay or artifical liners in the future to a greater degree than in the past to assure protection of valuable groundwater supplies. The technical and economic aspects of various landfill liners were discussed and it was concluded that both synthetic membrane liners and clay additives (e.g. bentonite) are applicable for particular site conditions and reasonably close in overall cost.

A cost impact analysis was also made to illustrate the impact of the Resource Conservation and Recovery Act (RCRA) regulations on future landfill disposal costs. The analysis showed that for the cases examined, a seven to ten fold cost increase may be expected in the future.

SOLID WASTE MANAGEMENT ASSESSMENT

A solid waste management assessment was undertaken to examine the following options which could be applicable to New Hanover County:

transfer stations	incineration
baling	sanitary landfills
shredding	

Generalized costing procedures as well as historic unit costs were presented to facilitate evaluation of various disposal options in the future. It was concluded that there was very limited economic information available on baling and shredding, and that modular incineration with and without energy recovery could be very attractive to the County.

RESOURCE RECOVERY

As a result of the resource recovery evaluation, it was determined that source segregation at the home for paper, and both large ferrous and non-ferrous items is practical on a limited basis. Material separation immediately before or after incineration is not considered practical for New Hanover County.

With regard to energy recovery, five criteria were proposed which experience has indicated must be present to have an economically viable energy recovery project. They are as follows:

- The availability of potential energy buyers
- Sufficient tonnage of processible solid waste
- Potentially available sites
- Available resource recovery technology
- A total disposal cost under resource recovery which is competitive with alternative disposal options available

These criteria should be utilized by the County when evaluating proposed projects in the future.

PBS&J have conducted an energy market survey and determined that there are at least six industries within the County which may provide a potential market for recovered energy.

FUTURE COUNTY ACTION ITEMS

The following are suggested action items which should be implemented by New Hanover County as soon as possible in order to expedite the resolution of their solid waste disposal problems:

1. Explore a limited source segregation program for waste paper.
2. Explore with the County solid waste consultant the observed differences in reported solid waste generation rates. These values are critical, especially if an energy recovery project is selected in the future, because of the substantial capital costs involved. If necessary consider implementing a weighting program to provide the necessary data base.
3. Examine any recommendations of the PBS&J report on energy recovery using the five evaluation criteria presented in Chapter 5.
4. If a recommended energy recovery project meets all of the above criteria, implement a feasibility study to address:

    - o the specific energy requirements of prospective customers
    - o Ascertain specific weight and composition data on available solid waste
    - o Develop strategies to insure the reliability of the project
    - o site location consideration
    - o Finalize the preliminary economics of the energy recovery project

5. Approach Brunswick, Columbus, and Pender Counties for possible participation in a regional solid waste management study. The regional approach is attractive since a long term landfill could be sited in a surrounding county with less associated environmental problems than the coastal environment in New Hanover County. The advantage to the other participating counties would be the lower disposal costs associated with operating a larger sanitary landfill.

CHAPTER 2

REVIEW OF SOLID WASTE COLLECTION, DISPOSAL AND CHARACTERISTICS

The following chapter describes the current solid waste collection and disposal practices carried out within New Hanover County and presents a brief chronology of the landfill disposal problems which have been experienced. In addition a summary of the management assistance rendered by ES to the County is presented along with a discussion of waste generation estimates previously presented to the county.

EXISTING SOLID WASTE COLLECTION AND DISPOSAL SYSTEMS

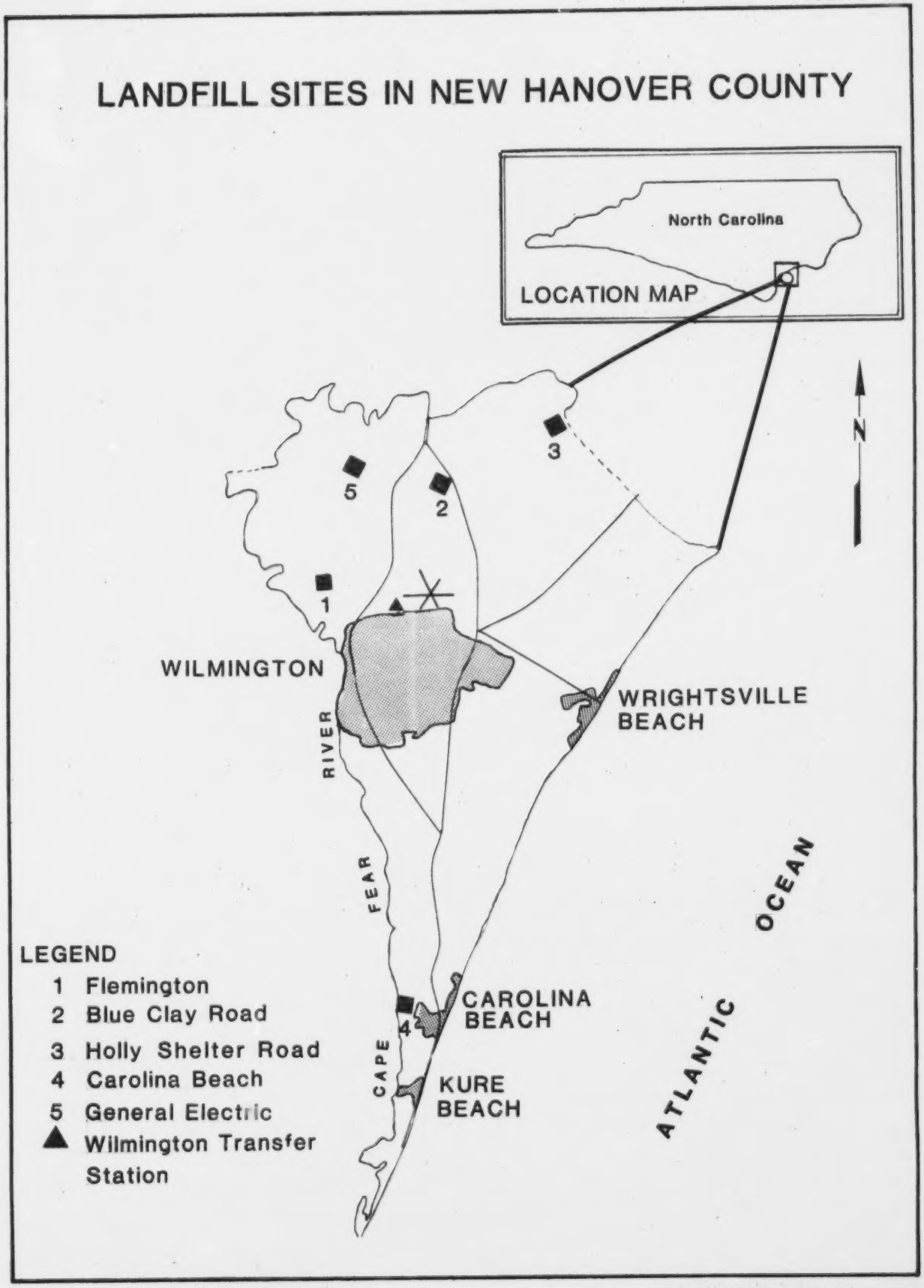
Existing solid waste collection and disposal systems within New Hanover County are divided along the following political jurisdictions; unincorporated New Hanover County, City of Wilmington, and the Towns of Carolina Beach and Wrightsville Beach.

Unincorporated New Hanover County

A mandatory collection system is not in effect in unincorporated New Hanover County, and rural and commercial collection are accomplished by approximately 13 private collectors on a fee basis, or on individual initiatives. A current ordinance of the Health Department in New Hanover County prescribes that the ordinance "shall not be construed to prevent any person from properly disposing of garbage or refuse from his own residence by burning it or burying it in a safe and sanitary manner." In order to provide mandatory collection in the county, this ordinance would require amending.

Prior to July 1, 1973, New Hanover County operated a landfill at Carolina Beach (See Figure 2.1) serving Wilmington and the unincorporated areas of the County. For economic and political reasons,

FIGURE 2.1


LANDFILL SITES IN NEW HANOVER COUNTY
North Carolina
LOCATION MAP
N
1
2
3
4
5
WILMINGTON
WRIGHTSVILLE BEACH
CAROLINA BEACH
KURE BEACH
CAPE FEAR RIVER
ATLANTIC OCEAN
LEGEND
1 Flemington
2 Blue Clay Road
3 Holly Shelter Road
4 Carolina Beach
5 General Electric
▲ Wilmington Transfer Station

the County decided to the County decided to close the site and franchise the landfill operation to a private contractor, Waste Industries, Inc. The firm conducted an extensive search for suitable landfill sites within the County and after much difficulty, obtained a site near Flemington (See Figure 2.1). Once the site was selected, the County agreed to close the Carolina Beach site and install a transfer station there. The County then entered into a five (5) year agreement with a private firm, Waste Industries, to operate the Flemington site.

At the end of the contract period, the County extended the agreement for a period of one (1) year to July, 1978. During that period, the County began negotiating with the owner of the land at the Flemington site to obtain a lease for an additional 150 acres to enlarge the landfill. An agreement was reached and in February of 1978, the County applied for a special use permit to allow for expansion of the landfill. It was at this time, that the issue arose concerning the contamination of nearby wells from leachate originating from the Flemington site. After an investigation by the State Division of Health Services confirmed leachate contamination, the County closed the existing site and immediately began to search for an alternative site. In early 1979, the County selected two (2) sites; one on Blue Clay Road and another on Holly Shelter Road, and submitted plans to the State for use of these sites. Both sites were eventually turned down by the State because of poor soils conditions and the potential of groundwater contamination.

In June, 1979, the County proposed to temporarily reopen the Carolina Beach site because an adjacent 25 acres had been found to be suitable for a landfill. The reopening of the site was proposed as an interim short-term solution for a period of one (1) year ending June, 1980.

As a result of the Phase I investigation by the County's consultant, PBS&J, six (6) prime areas were identified for possible siting of a sanitary landfill in New Hanover County.

A landfill siting permit was submitted to the State for the preferred site (the GE site) which is located on Figure 2.1. In mid-1980,

the County was informed by the State that the site was not acceptable due to potential groundwater contamination.

PBS&J has worked with the County to obtain permission to permit a temporary site located on Blue Clay Road, which is identified on Figure 2.1. The site opened on November 6, 1980.

In January, 1980, the EPA filed a civil suit in the U.S. District Court in Wilmington against Waste Industries and the New Hanover County Board of Commissioners requesting they address the following problems associated with the Flemington site:

- Provide a temporary water supply for those residents whose wells are contaminated
- Install a permanent water supply for those residential water users
- Abate contamination of the Flemington aquifer under the landfill and restore the aquifer to a condition commensurate with safe human use
- Maintain a groundwater monitoring program in the vicinity of the Flemington landfill.

City Of Wilmington

The City of Wilmington operates its own collection system for residential and commercial customers. The City has fifteen packers (including five spare units) for residential service and three units (including one spare unit) servicing commercial containers. The City owns a transfer station north of the city which is shown on Figure 2.1. The station has a capacity of 530 cubic yards per hour (cu. yd./hr) and is utilized only by city vehicles. At the current time, the transfer station processes approximately 152 cu. yd./hr[1] which is only 30% of its design capacity.

All solid waste processed by the transfer station is hauled to the existing county landfill located on Blue Clay Road.

Town Of Carolina Beach

The town of Carolina Beach operates its own collection system and landfill on US government land adjacent to the town. The town provides residential garbage pick-up and commercial dumpster service. During the winter months, Carolina Beach serves an estimated

2,000 persons and in summer swells to a season population of 8,000 to 10,000 persons.

Town Of Wrightsville Beach

The town of Wrightsville Beach has a population of approximately 3,500 people and currently operates its own collection system for both residential and commercial solid waste and disposes of its waste in a small package incinerator located within the town limits. The residue from the incinerator is disposed of on a site adjacent to the unit.

COUNTY MANAGEMENT ASSISTANCE

In late 1979, the County entered into an agreement with PBS&J to conduct the following three (3) phase solid waste study.

Phase I	Sanitary Landfill Site Selection
Phase II	Sanitary Landfill Design
Phase III	Long-Range Plans for Solid Waste Management

Phases II and III were to follow Phase I and were to be sequentially authorized as details of scope and recommendations were determined. Since the County decided to proceed with Phase II and Phase III of the PBS&J contract in early June, 1980, well before the conclusion of Phase I, assistance by ES in the form of comments on selected technical aspects of the latter phases was requested by the County. The comments were sent to the EPA Project Officer for review and were then forwarded on June 4, 1980 to the County Manager for information and consideration. The comments, as sent by EPA, are contained in Appendix A.

WASTE GENERATION ESTIMATES

In 1976, the Cape Fear Council of Governments (COG) issued a solid waste management report which addressed the following counties: New Hanover, Columbus, Pender, and Brunswick (Reference 1).

Residential and commercial solid waste generated within this planning area were reported as follows:

COUNTY	SOLID WASTE TONS/WEEK	1975 ESTIMATED POPULATION	PER CAPITA GENERATION LBS/CAPITA/DAY
City of Wilmington	701[1]	50,000	4.01
New Hanover (less Wilmington)	478[1]	42,000	3.25
Brunswick	333	35,000	2.72
Pender	304	18,200	4.77
Columbus	807	49,841	4.62

In 1968, U.S. Public Health Service published national average solid waste figures, excluding the industrial component, which were reported as follows (Reference 2):

AREA	GENERATION RATE LB/CAPITA/DAY
Urban	5.07
Rural	3.56
Average	4.73

Both New Hanover and Wilmington had per capita generation rates below the previous national average figures. One problem in comparing these rates is that Waste Industries estimated waste generation on the basis of the number of cubic yards, not on the basis of weight data.

In 1980, New Hanover's solid waste consultant, PBS&J prepared estimates of current residential, commercial and industrial solid waste currently being disposed of within the County (Reference 3):

[1]Since Waste Industries does not weigh loads, tonnages were approximated using an estimate of 450 lbs. per cubic yard.

AREA	SOLID WASTE TONS/WEEK	1980 CENSUS POPULATION	PER CAPITA RATE LB/CAPITA/DAY
City of Wilmington	1029	43,051	6.83
New Hanover County (less Wilmington)	961	57,649	4.76
TOTAL	1990[2]	100,700	5.65

This latter per capita estimate is approximately 68% higher than figures presented in the Cape Fear COG report. This difference is attributed to the fact that industrial solid waste currently being disposed in the County's landfill is included in these latter figures and additional weight/volume data available from the City of Wilmington indicated that a higher weight/volume conversion factor was appropriate. Since the PBS&J report was not available when this report was pepared, it was not possible to make a specific judgement regarding the data used to support the generation rates.

WASTE COMPOSITION

To facilitate subsequent discussion of resource recovery, it was necessary to estimate the amounts of various components in the County's solid waste (Reference 4). This information is presented in Table 2.1. It is interesting to note that paper represents 48% or almost 50,000 tons per year.

[2]Reported by PBS&J as 103,500 tons/year.

TABLE 2.1

ESTIMATED QUANTITIES OF VARIOUS COMPONENTS
MATERIALS IN MUNICIPAL SOLID WASTE (MSW)

	COMPONENT	PERCENT COMPOSITION	TON/YEAR[1]
Combustible	Paper	48	49,700
	Garbage	16	16,600
	Leaves and grass	9	9,200
	Wood	2	2,100
	Synthetics	2	2,100
	Cloth	1	1,000
Non Combustible	Glass	6	6,200
	Metals	8	8,300
	Ash, stone, dust	8	8,300
		100	103,500

[1]Current 1980 estimate prepared by PBS&J.

CHAPTER 3

SANITARY LANDFILL PRACTICES

The siting of a sanitary landfill in New Hanover County in the past required the consideration of a number of factors:

- Zoning
- Site Geology
- Site Accessibility
- Public Acceptance
- Location away from Groundwater Supplies
- Local Availability of Cover Material
- Location of Airports
- Low Soil Permeability[1]
- Groundwater Depth

Utilizing these criteria, the location of a landfill within the County has always posed a major problem. At 185 square miles the County is the second smallest in the state and it has the highest population density, 544 persons per square mile, of any of the coastal counties. In addition, over 57% of the County population and almost all of the major industries in the County obtain their water from groundwater supplies. Many of the domestic supplies are located in the unconfined, surficial sands located throughout the County with the larger industrial and community wells located in the Castle Hayne aquifer which is a limestone formation that reaches depths of 200 feet

[1] Permeability - rate at which water moves vertically through a soil. Coefficient of permeability is defined as follows:

$$Q = KIA$$

Q = Quantity of water discharged per unit time - cu.ft/sec.
K = Coefficient of permeability - ft/sec.
I = Hydraulic gradient - ft.
A = Cross sectional area through which water percolates - ft^2

in parts of the County. Groundwater depth in the surficial sands varies between 0 and 10 feet below ground level.

In the past most of the landfills sited within the County utilized the on-site materials for individual cell construction and cover. Typically, no lower permeability materials were brought on-site.

FEDERAL REGULATIONS

In 1976, Congress passed RCRA. As authorized by the law, EPA has issued a set of proposed regulations with regard to the disposal of solid waste (non-hazardous) in landfills (Reference 5).

The following are abstracts of the proposed regulations which will particularly impact on any future sites located in New Hanover County:

> Where natural hydrogeologic conditions are sufficient to ameliorate the impact of the total quatity of leachate (as it is formed) upon underlying groundwater, the bottom (and sides below natural grade) of the landfill should be lined with low permeability soil or other suitable material. The function of liner material is threefold: to delay the escape of leachate from the bottom of the liner for a period of time equal to the thickness of the liner divided by the liner permeability; to control the rate of escape of leachate from the bottom of the liner which must then be ameliorated by attenuation or dilution by underlying soils or groundwater; and to provide some degree of attenuation as leachate passes through the liner material.
>
> The quantity of leachate which must be handled by the liner can be minimized through selection and placement of low permeability cover soil to reduce the infiltration of incident precipitation.
>
> Liner materials which are to significantly restrict the rate of flow of leachate should have a permeability of 1×10^{-7} centimeters per sec (cm/sec) or less. Table 3.1 presents various leachate flow rates corresponding to various permeabilities, e.g. 1×10^{-7} is equivalent to a daily flow of 92 gallons per acre.

TABLE 3.1

LEACHATE FLOW AT VARIOUS PERMEABILITIES*

SOIL PERMEABILITY K	VERTICAL SEEPAGE PER DAY	VERTICAL FLOW
cm/sec	inches	gallons/acre-day
1×10^{-2}	340	9,230,000
1×10^{-3}	34	923,000
1×10^{-4}	3.4	92,300
1×10^{-5}	0.34	9,230
1×10^{-6}	0.034	923
1×10^{-7}	0.0034	92
1×10^{-8}	0.00034	9.2
1×10^{-9}	0.000034	0.92

*Under 1 foot of water head

If a natural soil is to be used as a liner, the minimum thickness should be twelve (12) inches. This is to compensate for irregularities in the surface of the sub-base and the insensitivity of some construction equipment in their spreading ability.

The practical minimum thickness for synthetic membrane liners is twenty mils.

The bottom of the landfill disposal facility should be substantially (5 feet or more) above the seasonal high groundwater table.

As the leachate contaminants leave a landfill, there is some degree of attenuation of the contaminants in both the unsaturated and saturated soils underlying the landfill disposal facility. At the present time, the procedures for estimating the attenuative capacities of underlying soils and groundwater have not achieved wide acceptance and the engineer is in the position, in most cases, of having to assume a conservative design in order to safeguard groundwater quality.

The rules proposed by EPA are broad guidelines and are not specific since there is a realization that the design of the landfill is truly site specific and an independent determination must be made in each case as to the value of the groundwater and the degree of conservatism which should be implemented by the design engineer.

However in the future since the County relies so heavily on groundwater, it is probable that landfill designs will specify natural or artificial liners. Figure 3.1 shows a typical clay lined cell meeting the above Federal regulations.

LANDFILL LINERS

Two techniques for lining landfills are the use of clay or artificial liners. The following subsection addresses the use of these materials as liners.

Clay Liners

Clay liners consist of natural, inorganic materials either as a virgin clay on the landfill site or as clay imported and mixed with virgin soil to lower its permeability. Because of the physical ability

TYPICAL HALF SECTION OF A SOLID WASTE LANDFILL CELL

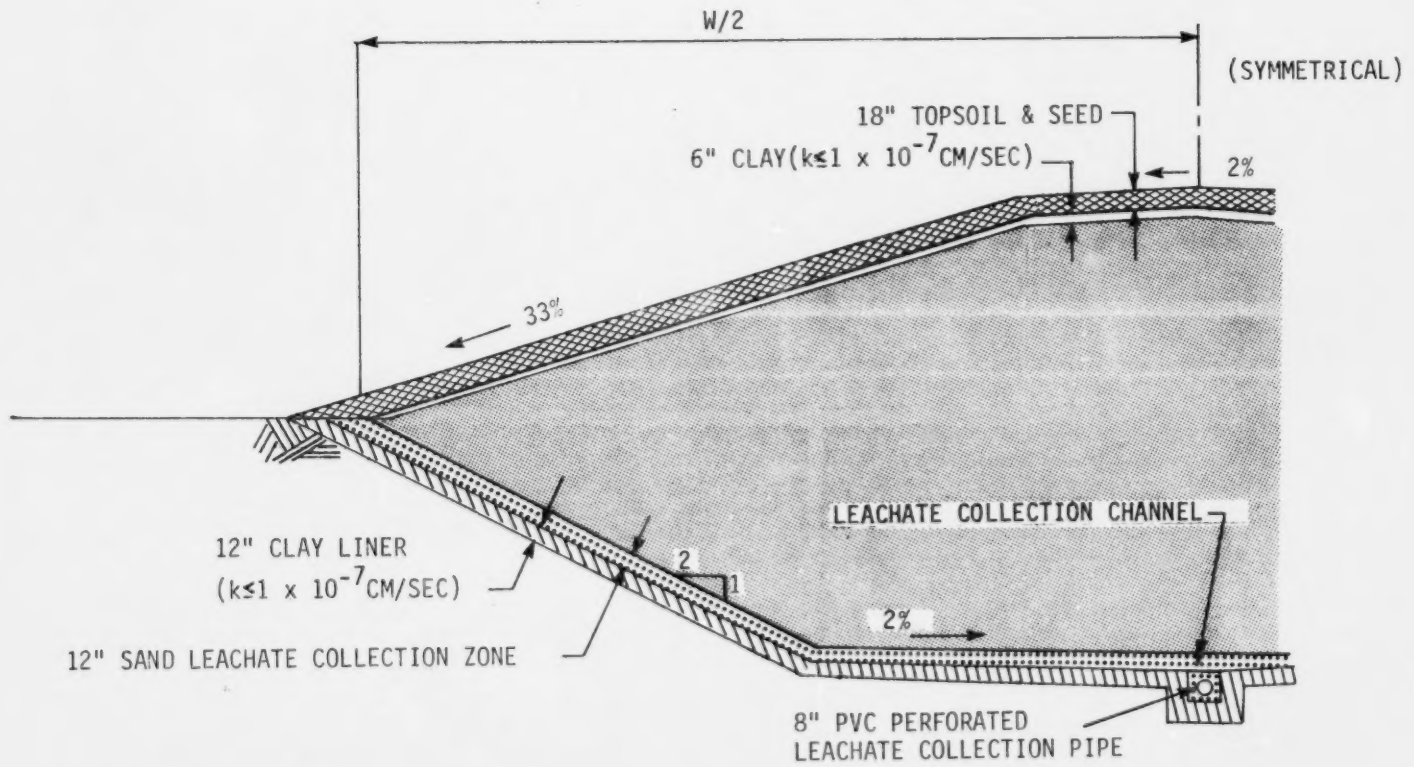


FIGURE 3.1

of these clay particles to change size and shape when moisture and pressure are applied and to form a solid matrix under the proper conditions, many clays are ideal for functioning as a natural liner for use at sanitary landfills. When importing clay to a landfill site, it is customary to purchase it locally and have it hauled by truck from a borrow area, or to purchase the clay in dry form from a firm specializing in clay additives.

Based on discussions with the Soil Conservation Service, it is unlikely that there are any borrow areas within the County with clay having a permeability of $1x10^{-7}$ cm/sec. The closest area is probably Craven County which is about 90 miles (one way) from Wilmington.

Bentonite is a clay which is typically used as a local soil additive to lower permeability. The effectiveness of clay additives is directly dependent on the following:

- o Amount of clay additive used
- o Virgin soil and moisture
- o The mixing and compaction of the components

In the mixture, the virgin material gives the strength and closes most of the soil pore openings. The additive swells and bridges the remaining openings with the help of the added moisture. It is possible, in soils laboratory tests, to determine the best combination of virgin soil, clay additive and moisture to provide the minimum permeability at the specified compacted density.

There are at least two critical operational parameters which must be addressed during installation. They are freezing and moisture content. If the clay liner is allowed to dry, or freeze, excessive cracking can occur which will impair its integrity. The significance of moisture content was discussed in the preceeding paragraph.

Artificial Liners

There are three major groupings of artificial liners which are being proposed for use in landfills:

Asphalt liners

Additive Polymer and Chemical Sealants

Plastic membrane liners

Asphalt liners are most effective where installation conditions are closely controlled, and the depth of the soil cover is thick and therefore protects the liner material. Covers can be applied as asphalt cement or soil asphalt. It can be rolled, sprayed, or squeezed on to a well prepared surface. Most of the installed asphalt liners are at water reservoirs where conditions are well controlled and more uniform than at a sanitary landfill. The use of asphalt for a landfill application should be approached with care.

Polymer and other new chemical sealant additives can form a stabilized soil surface of low permeability if composition, moisture content, blending rate, method of application and compaction are closely controlled. This type of sealant is generally more susceptible to deterioration by chemicals likely to be found at a landfill than are other types of artificial liners.

Plastic artificial liners are available in many materials and thicknesses with different additives and types of reinforcement. Some of the materials include the following:

- o Butyl
- o Chlorinated polyethylene (CPE)
- o Ethylene propylene rubber (EPDM)
- o Hypalon
- o Neoprene
- o Polyethylene
- o Polypropylene
- o Polyvinylchloride (PVC)

Thickness of liners commonly used varies from 20 mils to 47 mils (.020 to .047 inches).

Additives impart one or more of the following characteristics to a flexible synthetic membrane liner:

- o Tensile strength
- o Elongation qualities
- o Sunlight resistance
- o Flexibility at various temperatures
- o Ozone resistance
- o Tolerance for particular types of chemicals

Reinforcement can consist of woven plastic, glass filaments or other material. Various types of reinforcement add the following

characteristics to plastic liners:

- o Tear resistance
- o Seepage resistance
- o Strength.

Table 3.2 indicates general properties of six materials which are being used as flexible membrane liners at reservoirs. More detailed information is available from laboratory tests indicating the specific effect of chemical compounds on flexible liner materials. (Reference 6, 7, 8, 9, 10). The best design would incorporate the material that would be most apt to remain unchanged by the wastes most likely to be landfilled above it. For landfills handling municipal solid waste including select non-reactive industrial waste, chlorinated polyethylene and polyvinyl chloride are effective liner materials.

LANDFILL LINER COSTS

Figure 3.2 illustrates the estimated cost range of a clay additive varying with the delivered cost per ton and the application rate. For example, bentonite clay, at $100 per ton FOB the landfill site, applied at a rate of 5 pounds per square foot would cost about $11,000 per acre of landfill bottom liner or $2.30 per sq. yd. To this must be added the spreading and compaction cost which may range from $1.00 to $1.50 per sq. yd. for a range of $3.30 to $3.80 per sq. yd.

Table 3.3 contains the estimated costs of various artificial liners FOB the landfill site. To these costs must be added the installation cost including preparation of the base and spreading 2 feet of material over the liner to protect it from mechanical damage. Installation costs may vary between $1.70 and $2.20 per sq. yd. Typical total costs may range between $3.70 and $4.20 per sq. yd. for 30 mils unreinforced chlorinated polyethylene.

As can be seen, the costs between clay additives and membrane liners are comparable. Technically either clay or artificial liners could be used by the County for a future landfill.

TABLE 3.2

GENERAL PROPERTIES OF FLEXIBLE MEMBRANE LINER MATERIALS*

Property	Polyethylene		Polyvinyl Chloride#	Chlorinated Polyethylene	Poly-propylene	Butyl Rubber	Hypalon	Ethylene-Propylene Rubber (EPDM)
	Low Density	High Density						
Specific Gravity	0.92-0.94	0.94-0.96	1.24-1.30	1.35-1.39	0.9-0.91	0.92-1.25	1.4-1.5	1.15-1.21
Tensile Strength, psi	1,300-2,500	2,400-4,800	2,500-3,500	1,800 min	4,000-32,000	1,000-4,000	1,000-2,000	1,300-1,500
Elongation, %	200-800	10-650	250-350	375-575	40-400	300 min	300-500	300 min
Shore "A" hardness	N/A	N/A	65-75	65-75		45-80	55-95	50-70
Operating Temperature Range, F	-70 to 180	-70 to 240	-60 to 200	-40 to 200	-60 to 220	-50 to 325	-45 to 200	-75 to 300
Resistance to Acids	P-G	G	G-E	G-E	G-E	G	G	G-E
Resistance to Bases	G-E	G-E	G-E	G-E	G-E	G	G-E	G-E
Resistance to Oxygenated Solvents	P-G	P-G	G	P	P	G-3	G	G-E
Resistance to Aromatic and Halogenated Solvents	F-G	F-G	G	P	G	P	F	P
Resistance to Aliphtic (Petroleum) Solvents	F-G	F-G	G	G	G	P	G	P
Water Vapor Permeability, perm-mils	3-14	1.8-2.2	3-18	0.04-0.048	0.25-1.0	0.15	2.0	2.0
Weatherability	P-w/o black	P-w/o black	P-F	E	P-w/o black	G	E	E
Time to Crack, hr	900	300	No crack to 2,500	No effect to 4,000	100	No effect after 2,500	No effect after 1,000	No effect after 1,000
Time to Chalk, hr	No effect to 2,500	600	300	No effect to 4,000	600	No effect after 2,500	No effect after 1,000	No effect after 1,000
Time to Fade, hr	300	300	100	No effect to 4,000	900	No effect after 2,500	No effect after 1,000	No effect after 1,000

*Adapted from Kumar, J., and Jedlicka, J. A. Selecting and Installing Synthetic Pond Linings. Chem. Eng., 80 (3): 67-70, 1973 for State of the Art Study adapted for this report.

#Plasticized PVC

N/A Not available for original authors

P-poor, F-fair, G-good, E-excellent. ASTM test methods for various properties: specific gravity, D-751; tensile strength, D-97-61T; elongation, D-412-61T or D-882; shore "A" hardness, D-676-59T; water vapor permeability, E-96-66.

FIGURE 3.2

COST OF CLAY ADDITIVE FOR LINER MATERIAL IN DOLLARS PER ACRE

1980 DOLLARS

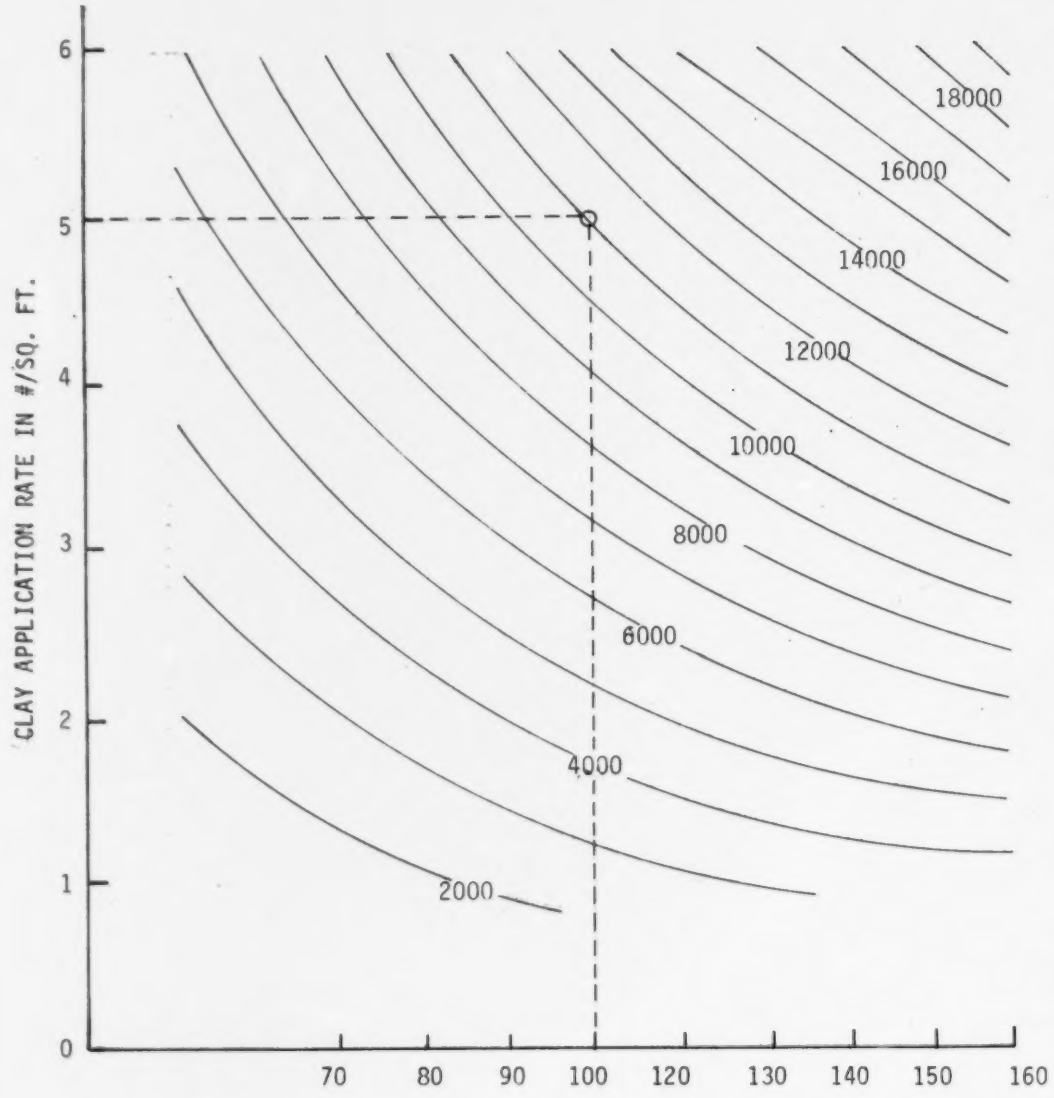


TABLE 3.3

COST OF LANDFILL LINER ROLL GOODS (1980 DOLLARS)

MEMBRANE MATERIAL	THICKNESS IN MILS	COST PER SQUARE YARD	ESTIMATED INSTALLED COST PER ACRE
Chlorinated Polyethylene (CPE) Unreinforced	20	$1.29	$12,500
	30	2.09	20,300
Chlorosulfonated polyethylene (Hypalon) w/Nylor Scrim	30	3.07	29,800
Ethylene Propylene Rubber (EPDM) Unreinforced	45	5.58	54,200
	60	6.48	62,900
	90	9.72	94,400
Neoprene, Unreinforced	45	8.10	78,600
	60	9.54	92,700
Polyvinyl Chloride	10	0.49	4,800
	20	0.89	8,600
	30	1.41	13,700

Source: Telephone Contacts with Pantasote, Inc., Staff Industries and Carlisle Tire & Rubber Company

LEACHATE COLLECTION/TREATMENT

Recent proposed rules, issued by EPA under the authority of RCRA, also address leachate collection and treatment. The proposed regulations state that "landfill leachate generation cannot be avoided except in some arid climates, therefore, leachate control measures for water quality protection should be incorporated in the site design."

Figure 3.3 shows a typical leachate collection system which would be applicable in New Hanover County. Cross sections A and B are shown in Figure 3.4. The collection system is laid out with detection sumps for each cell to allow for monitoring of leachate from a specific area.

SANITARY LANDFILL COSTS

In the future, New Hanover County will be in the position of having to address EPA's RCRA regulations as promulgated. To allow the County to evaluate future situations, cost data have been prepared in Figure 3.5 which compares ranges of capital costs for existing landfill facilities. In addition, using the design information shown in Figures 3.1, 3.3 and 3.4 and presented in Table B.1 (see Appendix B), ranges of costs were developed for meeting EPA's proposed landfill regulations. The cost comparison indicates a five fold increase in capital cost between existing and proposed costs when RCRA design requirements are adhered to.

Figure 3.6 contains a comparison of ranges in operating and maintenance (O&M) costs for landfill facilities. Of interest is the fact that RCRA regulations will have only a 10 to 20 percent increase in O&M costs while as shown in Figure 3.5 the capital costs will increase between 300 and 400 percent.

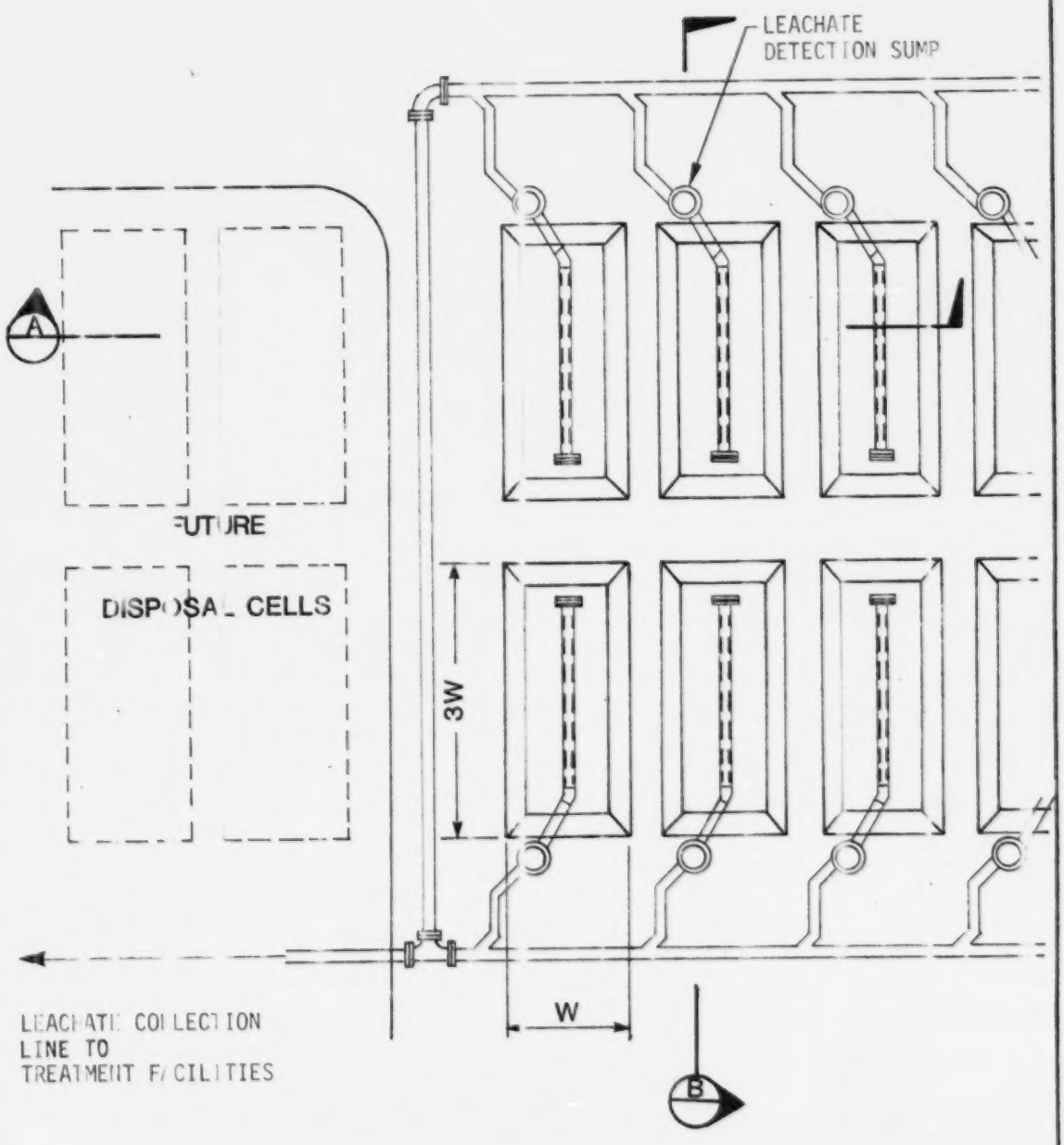
Using Figures 3.5 and 3.6 and the 1980 County solid waste projections of 1990 tons/week (see Chapter 2), it is possible to develop the following ranges of projected disposal cost when RCRA stantards are met.

Item	Cost Range Dollars x 10^6	Range of Unit Costs[3] Dollars/cu.yd.
Capital Cost	3.4-5.8	7.4-12
O&M Cost	0.7-1.1	1.5- 2.4
TOTAL	$4.1-6.9	$8.9-14.4

[3]Solid waste generation 1,990 tons/week @ 450 lb/cu. yd. is equivalent to 457,000 cu. yd./yr.

FIGURE 3.3

TYPICAL LEACHATE COLLECTION SYSTEM



NOTE: SEE FIGURE 3.4 FOR SECTIONS A&B

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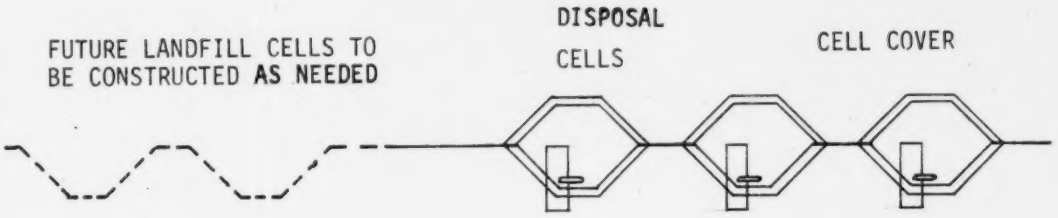
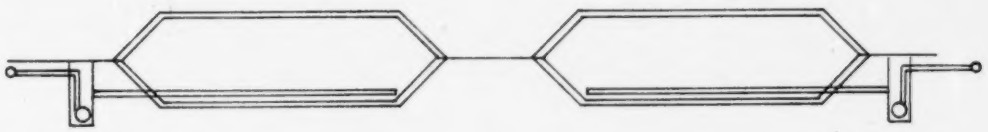
TYPICAL CROSS SECTIONS OF A SOLID WASTE LANDFILL


FUTURE LANDFILL CELLS TO BE CONSTRUCTED AS NEEDED
DISPOSAL CELLS
CELL COVER
LEACHATE COLLECTION SUMPS
LEACHATE COLLECTION AND LINER SYSTEM

SECTION A



SECTION B

CAPITAL COST COMPARISON FOR EXISTING SANITARY LANDFILLS AND FUTURE LANDFILLS MEETING RCRA STANDARDS

Source: Reference 11

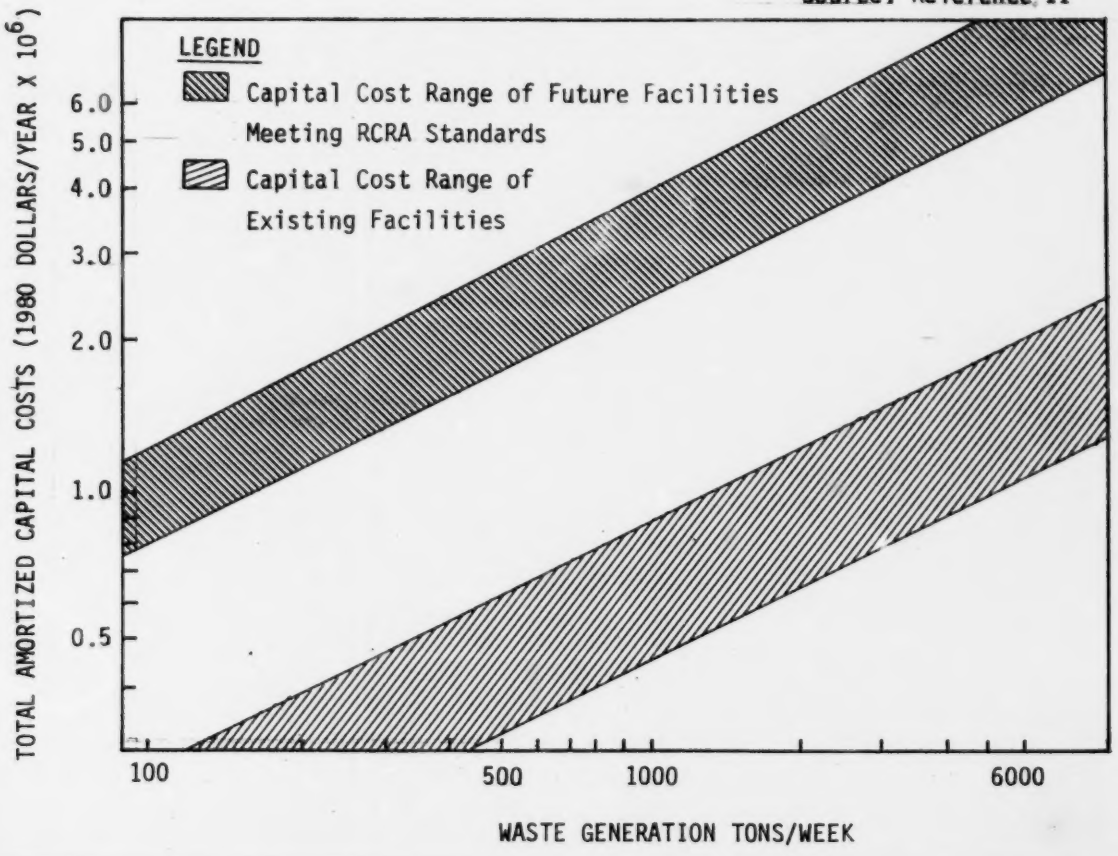
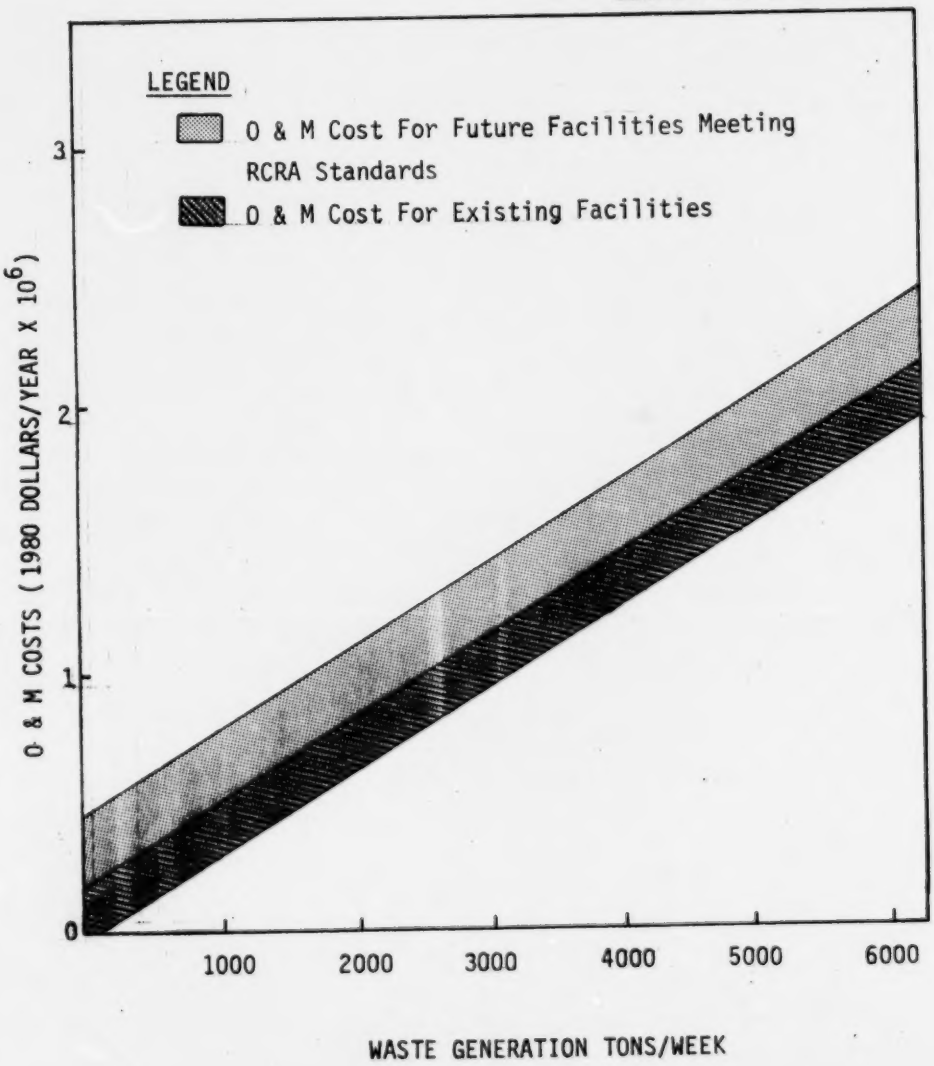


FIGURE 3.5

FIGURE 3.6

O & M COST COMPARISON FOR EXISTING SANITARY LANDFILLS AND FUTURE LANDFILLS MEETING RCRA STANDARDS

Source: Reference 11



ENGINEERING-SCIENCE, INC.

The current disposal cost charged at the Blue Clay Road site is $1.26/ cu. yd. which is substantially below the above projections, thus illustrating the tremendous impact RCRA regulations will have on future disposal costs. The specific effect of RCRA on the County's disposal budget is a concern but is outside the scope of this study and as a consequence was not evaluated.

CHAPTER 4

SOLID WASTE MANAGEMENT ASSESSMENT

The objective of this assessment was to identify solid waste management options that may be applicable to the needs of New Hanover County. The assessment focused on options that could be implemented fairly rapidly by the County. Emphasis was placed upon existing options for which prototype data are available. Using this approach, the prescreening of options was made for the purpose of providing input to the County for a more rigorous future analysis.

Table 4.1 presents solid waste management options available to the County. Each of the transportation, preprocessing, and processing components may be implemented individually or in combination to achieve the desired technical and economic objectives. For ease of discussion, all of the options dealing with resource recovery shown in Table 4.1 are presented in Chapter 5.

TRANSFER STATIONS

As explained in Chapter 2, the City of Wilmington currently hauls all of its municipal solid waste to a transfer station located just north of the City (see Figure 2.1). The station is currently operating at 30 percent of its design capacity. The unincorporated areas of the County are served by private collectors who do not utilize the City's existing transfer station.

SOLID WASTE MANAGEMENT OPTIONS

TRANSPORTATION	PREPROCESSING	PROCESSING	FINAL DISPOSAL
Collected Refuse Source Separation ▶ Transfer Station	▶ Shredding Baling Recovery	▶ Incineration Incin. w/ Heat Recovery Incin. w/Material Recovery Incin. w/Heat & Material Recovery	▶ Residue Disposal Sanitary Landfill

Transfer, processing, and preprocessing are not essential ingredients to a successful solid waste management system, but can be implemented individually or in combination to achieve desired technical and economical objectives.

TABLE 4.1

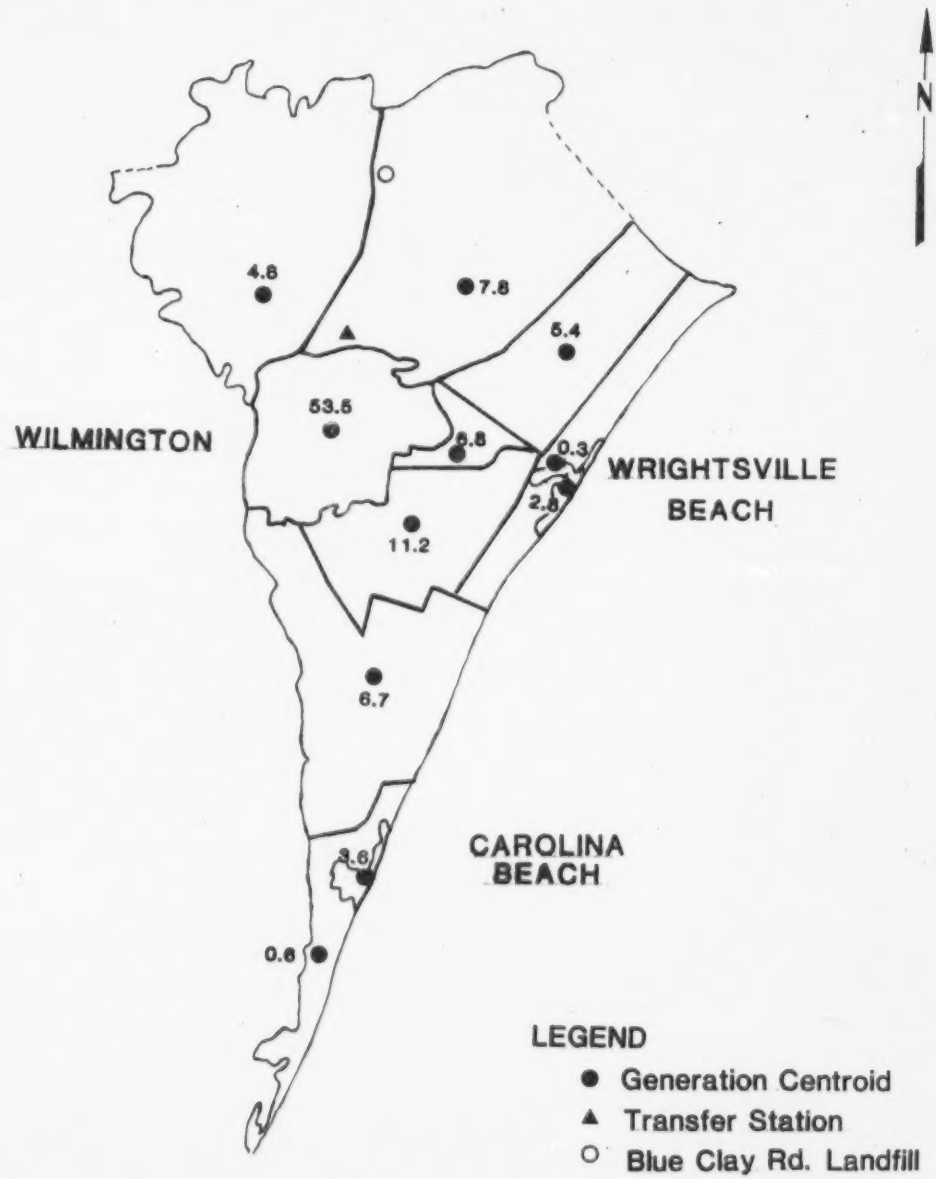
Figure 4.1 shows 1980 solid waste centroids for the County. A centroid represents a central collection point at which the load hauled times the hauling distance from several generation points is minimized. The solid waste quantities in Figure 4.2 were based on the 1980 estimate of 103,500 tons/yr. (equivalent to 1990 tons/week). The individual areas on Figure 4.1 correspond to existing census tracts.

Since the existing Blue Clay site is permitted on a temporary basis, it was not possible to develop any transfer station cost information which would be applicable to future solid waste management alternatives. The County has a number of solid waste management options available which will impact on the location and operation of one or more transfer stations. For example, if a new landfill site is located in the southern part of the County or resource recovery is implemented, it may prove to be most economical to abandon the existing transfer station and construct another one in a more optimal location. Therefore, it was decided to present a generalized economic evaluation procedure for transfer stations which could then be utilized in the future when evaluating various solid waste management alternatives.

Figure 4.2 is a graphical presentation of cost data versus round trip transfer times (Reference 12). For a transfer system, the haul cost in a transfer trailer must be added to the cost of operating and amortizing the transfer station. Three cost curves are presented for hauling solid waste in collection trucks with one, two and three man crews. Where the curve for transfer trailer hauling intersects the collection truck cost lines, this is the point where the cost is shown to be equal. Therefore, any round trip which takes an amount of time equal to or greater than this intercept time indicates it would be more economical to utilize a transfer station. The generalized technique for developing the cost information which is presented in Figure 4.2, is presented in Table B.2 (see Appendix B).

In the future, when various solid wastes management alternatives have been delineated in detail, it will be possible to use the information developed in Figure 4.1 which is the distance between solid

1980 SOLID WASTE GENERATION CENTROIDS NEW HANOVER COUNTY



NOTE:
All generation figures are expressed as 10^3 Tons/year

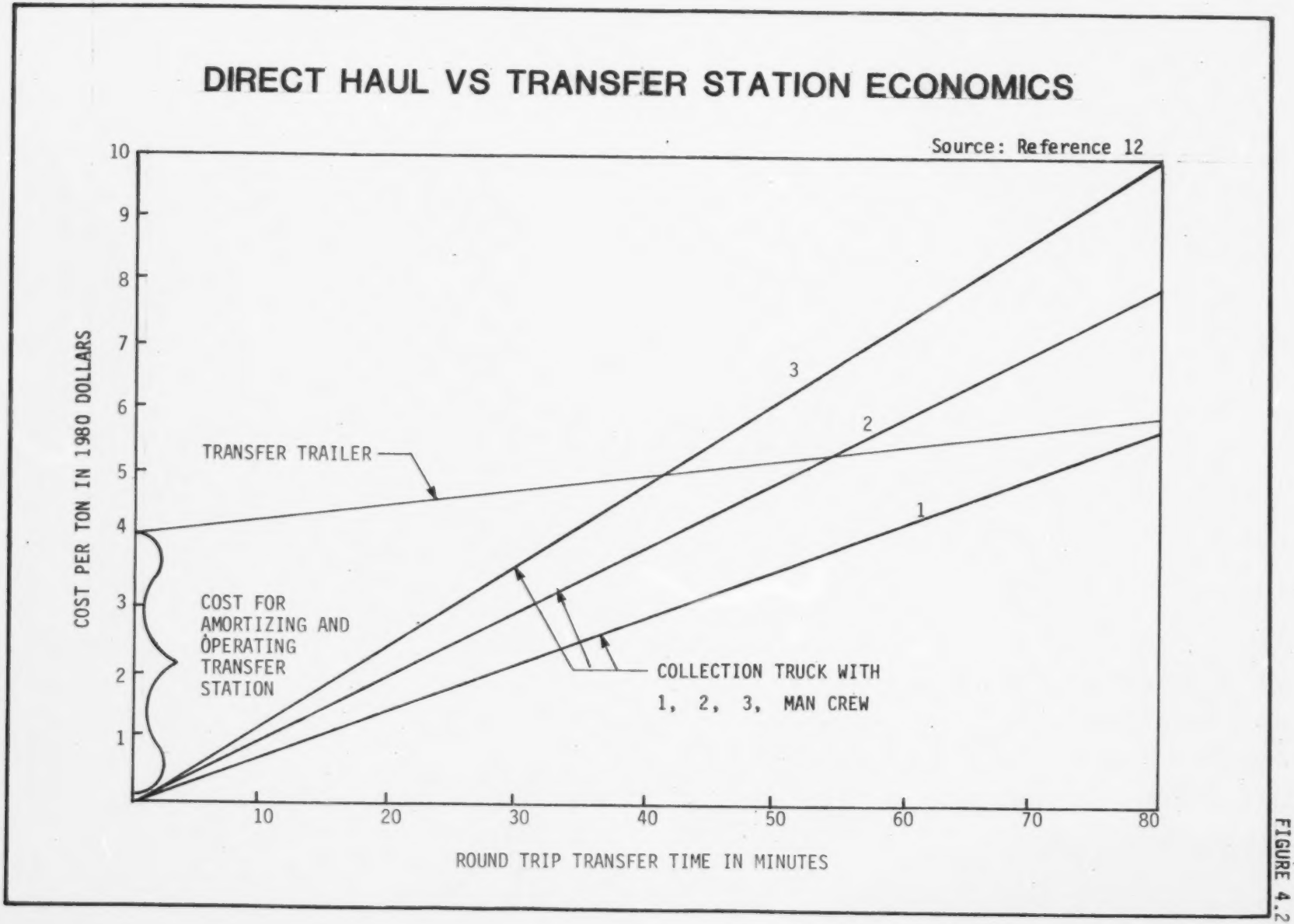

DIRECT HAUL VS TRANSFER STATION ECONOMICS
Source: Reference 12
COST PER TON IN 1980 DOLLARS
10
9
8
7
6
5
4
3
2
1
TRANSFER TRAILER
COST FOR AMORTIZING AND OPERATING TRANSFER STATION
3
2
1
COLLECTION TRUCK WITH 1, 2, 3, MAN CREW
10
20
30
40
50
60
70
80
ROUND TRIP TRANSFER TIME IN MINUTES

FIGURE 4.2

waste generation centroids to determine round trip travel times. With this information it will be then possible to utilize Figure 4.2 to make an assessment as to the practicality of direct hauling versus the utilization of a transfer station.

SHREDDING

Shredding can significantly reduce the volume of wastes, especially bulky wastes. When compacted in a landfill, shredded waste density is 25 to 60 percent greater than unshredded, depending on whether daily cover is required. (Reference 12).

There are 11 basic types of size reduction equipment commercially available - crushers, cage disintegrators, shears, shredders, cutters and chippers, rasp mills, drum pulverizers, disk mills, wet pulpers, hammermills, and grinders. To date, wet pulpers, hammermills, and grinders have been used in the United States for the size reduction of municipal solid waste. Of these three equipment types, the hammermill is most commonly used in solid waste applications.

The size of the particles produced is quite important to the effectiveness of the step following shredding. The shredding system must be capable of meeting the particular size requirements. Hammermills have provisions for mechanical particle-size control. Besides these provisions, however, other factors can affect particle size, including wear of components within the shredder, the moisture content of the waste, number of hammers used within the shredder, waste composition, and feed rate (tons per hour).

A large portion of the total solid waste load can be shredded. Some wastes, however, cannot be put through the mill because of size or density or because they are hazardous, have high moisture content, or have other qualities that normally call for specialized handling in any system.

Long-term experience in shredding solid waste is still lacking, but the major problems have been identified and significantly reduced. These problems usually center around the materials handling aspect of

feeding the mill and subsequent removal of the shredded material. Jamming of the shredder and uneven feeding can significantly reduce the throughput of the mill, although this has generally been solved on a local basis by simple field adjustments. This uneven feeding can result in uneven hammer loading and wear, as well as surges in power. At the other end, unless the shredded material is rapidly removed from the mill, a backup jam may occur.

Cities with a severe shortage of landfill space and/or cover material might consider shredding if local conditions permit. Local regulatory authorities should be contacted to determine how present regulations would affect landfilling of shredded wastes. Other than cover requirements, all normal sanitary landfilling procedures must be followed in landfilling shredded waste; under certain conditions, consideration must be given to leachate collection and treatment.

Because shredding involves an additional processing step over landfilling, additional operating and capital costs are incurred. Ten shredding facilities were surveyed under EPA contract in 1975 (Reference 12). The operating costs and the annualized capital cost for the 10 shredder sites were updated to 1980 costs using ENR cost indexes. The sites had an average operating cost per ton of $8.36 and an average annualized capital cost per ton of $2.52, resulting in a total cost per ton of $10.88. The operating cost averaged 77 percent of total costs. All costs reflect the operation of the shredder facility itself and the transportation of the shredded waste to a landfill, but not costs of transporting to shredder nor cost of landfilling shredded material.

If incineration either with or without energy recovery (See discussion and Chapter 5) is not economically attractive in the future then the shredding of waste is a method of reducing future County landfill capacity requirements by as much as 30%.

BALING

Baling is another method of reducing the volume of solid waste. It has the potential to achieve cost savings when transfer and long haul are necessary prior to disposal and when land disposal space is

at a premium. It also has an added benefit in that baling makes the waste potentially easier to handle and transport. A decision to implement baling depends on how well the operation of the balefill competes with other processes and conventional landfilling. In other words, the comparison should be made on an economic and environmental basis for New Hanover County. The different forms of of baling must be compared with each other as well.

There are, at present, three main types of solid waste balers: a multistage baler with no preprocessing; a horizontal, continuous pushthrough baler with preshredding; and a baler developed from that used for corrugated materials at supermarkets with no preprocessing.

Because of the relative newness of solid waste baling technology, firm cost figures are very difficult to establish. For two baling projects in which EPA has been involved, costs per ton were $9.50 and $13.70, respectively (costs were updated to August 1980 using ENR cost indexes). (See Reference 13). Projected economics available for other locations indicate costs ranging from $8.79 to $9.98 per ton (August 1980 costs).

Advantages of baling operations are:

- Baling nearly doubles the life of the land disposal site and therefore reduces the number of times the County must go through the difficult process of acquiring a new disposal site. Densities vary from 1,000 to more than 1,700 pounds per cubic yard, depending on the type of baler used.
- Balers can handle most types of wastes.
- Bales are easier to handle and transport than unprocessed waste; they are therefore more convenient for operations such as rail hauling.
- Baling should permit more immediate use of the disposal site upon completion as minimal settling is anticipated.
- In shredding/baling operations, ferrous metal can be recovered for recycling via magnetic separation after shredding.

Also corrugated containers and white goods can be handpicked and baled separately and sold.

Disadvantages include:

- o Baling involves a greater initial investment than a conventional transfer station handling the same tonnage.
- o Baling precludes resource recovery once the bale is formed.
- o There is limited information about the economics of baling and the effects of baling on decomposition in landfills, gas and leachate formation, and settling.

Until additional operating information becomes available, baling should not be considered a viable waste reduction alternative for the County.

INCINERATION

Mixed municipal solid waste, on the basis of weight, is composed of more than 75% combustible materials (See Table 2.1). This latter weight figure is equivalent to more than 90% of the volume. Historically thermal reduction has referred exclusively to incineration in refractory-lined chambers. Recently, however, solid waste disposal technology has developed new ways of thermally treating solid waste to minimize air pollution as well as maximize energy recovery. One of the most applicable, new, proven technologies is modular combustion units which operate under a technology referred to as starved-air incineration. The incinerator consists of two combustion chambers. In the first chamber, the waste is burned in an oxygen-starved environment. The off-gases then proceed to a secondary chamber where complete combustion takes place. This minimizes particulates being discharged in the off gases. Stricter air pollution requirements will place additional pressure on using auxiliary fuel to insure a high degree of combustion. This increased fuel usage will tend to increase already high operating costs.

Incineration is an attractive alternative when land availability is a major constraint or when a market does not exist for energy recovery. In the absence of an energy market, incinerators could be designed to accommodate waste heat boilers in the future and the

siting undertaken to attract industry to an industrial park. For these reasons, it is felt that incineration has potential in the situation of New Hanover County both with and without energy recovery. Energy recovery criteria are discussed in more detail in Chapter 5 of this report.

SANITARY LANDFILLS

As was illustrated in Figure 4.1, the County is faced with locating a long-term sanitary landfill irrespective of the solid waste management alternative finally adopted. All solid waste handling techniques require the disposal of a residue ultimately in a sanitary landfill. The previously discussed options will, however, affect greatly the volume of this residual material.

The only other solid waste management technique which has not been discussed is a regional approach which would examine optimal disposal strategies including one or more counties surrounding New Hanover. Under this regional approach, it is possible that a long term sanitary landfill could be sited in one of the surrounding counties which would not have the environmental problems associated with the coastal environment in New Hanover County and provide more cost effective, environmentally sound alternatives for all participating entities. However, this option was outside the scope of this study and as a consequence was not evaluated.

CHAPTER 5

RESOURCE RECOVERY

One of the solid waste management options available to the County as discussed in Chapter 4 is resource recovery. The recovery option is available at various steps as solid waste proceeds from the generator to its ultimate disposal in a sanitary landfill (See Table 4.1). To facilitate the discussion of resource recovery, it was decided to present all of the pertinent recovery options in the a separate chapter. Resource recovery involves materials recovery, energy recovery, or both.

MATERIALS RECOVERY

MSW contains several materials that can be recovered and used to replace virgin materials in the manufacture of various products. Materials most commonly recovered from MSW are:

Metal

- White goods (e.g. refrigerators)
- Tin cans
- Aluminum (e.g., cans, foil)

Paper

- Newsprint
- Corrugated
- Office grades

Glass (containers)

Materials recovery provides a community with cash revenue while reducing waste flows to its landfill. A successful materials recovery system requires reliable markets that are willing to accept materials of the type and purity that the community can recover; the recovery system must also be applicable to the community's wastestream and solid waste practices.

APPROACHES TO MATERIALS RECOVERY

The following subsections present brief descriptions of the most common approaches to materials recovery, in order of increasing complexity, and a summary of market options for several materials.

Ordinance

A municipal landfill may refuse to accept a particular waste type if the municipality passes an ordinance and controls traffic at the disposal area. This approach is practical when there is a way of recovering the diverted material (e.g., junk autos). In the past, ordinances for junk autos have stabilized the market and increased the price. Other categories of waste can be excluded from the landfill if long-term outlets are available. For example, corrugated paper generated by industries or commercial establishments could be sent directly to paperstock dealers; white goods generated by citizens could be picked up by special arrangement with a local scrap dealer; or clean rubble from demolition projects could be directed to land reclamation areas where "clean fill" can be safely used. The use of an ordinance to regulate waste types has a direct applicability to New Hanover County.

Disposal Area Segregation

With this approach, uncontaminated waste streams delivered to a landfill, transfer station, or processing facility are stored separately from other waste, for later sale or reuse. Some of the materials

stored in this way, and some typical methods of handling them, are shown in the following table:

Material	Method/Use
Trees, waste lumber	Stored in designated area. Available to citizens as firewood.
Brush	Chipped by municipality. Available for public works or citizen use.
Leaves	Windrow compacted by municipality. Compost available for public works or citizens use.
Tires	Stored in designated area. Portion to tire recappers; remainder stored for future potential energy recovery.
White goods: miscellaneous bulky ferrous metal	Stored in designated area. Sold to scrap dealers.
Stabilized[1] sewage sludge	Stored in designated area. Used as topsoil blender for final landfill cover.
Incinerated sludge ash	Blended with soil and used as daily landfill cover.

It is felt that some of the above materials, specifically trees brush and white goods, should be considered by the County for incorporation into a segregated disposal area.

Recycling centers

Of all methods of materials recovery, direct delivery of materials by citizens to recycling centers is best known and most widely practiced. The largest portion of the post-consumer wastes recovered is delivered to recycling centers. Centers can be established at solid waste disposal areas, transfer stations, or other convenient locations; they may be staffed by volunteers, or run by public or private companies. The materials recovered at recycling centers are those commonly found in residential refuse (e.g., glass, newsprint aluminum, tinned steel cans).

[1]Stabilized according to state environmental and public health regulations. Authorized methods may include digestion, lime stabilization, and composting.

The major advantages of using recycling centers are their simplicity, low start-up costs, and the high quality of the material recovered. However, few communities can achieve a waste stream reduction of more than 5 to 10 percent. It is felt that recycling centers would not be attractive to New Hanover County. The recycling of newspapers is in curbside pickup, described below.

Curbside pickup

With this approach, source-separated materials are left at curbside for recovery at prescribed intervals. Householders store the materials--e.g., newspapers, glass separated by color, aluminum containers or, possibly, a mixture of cans and glass-separately from mixed refuse. In one variation of this method, one or more type of materials is set out weekly with the mixed refuse on the normal collection day; collection crews place the recycled materials in racks mounted on (or trailers towed by) the refuse collection vehicle, or separate crews collect recyclables with special vehicles. Other variations are less frequent separate collections by municipal crews or private contractors, or infrequent collections by volunteers (e.g., semiannual newspaper "drives" by Boy Scouts or Girl Scouts).

Curbside collection can recover yields of medium-to-high quality material amounting to 10 to 20 percent of the waste stream. In well-run programs the cooperation of large percentages of residents has been realized, and collection costs have been offset by materials sales and decreased disposal costs. However, the method is normally suited only to municipalities having organized collection systems and the capability to manage such a complex undertaking. A curbside source-separation program can complement an energy recovery system by 1) increasing the total tonnage recovered, i.e., decreasing the amount to be landfilled; 2) decreasing the tip fees that the energy recovery system must charge a town, especially when large hauls are involved; and 3) reducing the glass content of the waste stream and, hence, reducing the abrasion of plant machinery and ash content of the fuel.

Curbside collection of newspapers in county areas with organized collection (eg., the City of Wilmington) should be investigated further.

Postincineration recovery

Although somewhat less complex than preincineration or "front-end" recovery, postincineration recovery yields fewer products, less tonnage, and lower market values. Some grades of ferrous metals may be recoverable after burning, with magnetic and simple cleaning techniques. However, ferrous recovered in this way may be damaged, and its market acceptance and price will be low. Other materials, such as glass and ash, have been recovered on an experimental basis after incineration but not under commercial operating conditions. For these reasons, postincineration recovery is not a practical alternative for the County at this time.

Front-end separation

Several materials can be recovered from mixed refuse, using a series of mechanical processes; however, extraction of saleable materials from a mixed waste stream is technically difficult. Front-end separation involves expensive equipment, and a throughput tonnage of more than 1,000 TPD is typically required to defray the high operating and capital costs. Even with this throughput, front-end separation usually cannot be justified, except as a byproduct of refuse-derived fuel (RDF) preparation. Ferrous extraction, however, may be economically practiced on a small scale, because the technology for magnetic separation is simple and widely used. But even with ferrous recovery, product quality, markets, and economics are uncertain. Overall, front-end materials separation is probably not suitable for New Hanover County because of high capital costs and variable market conditions, discribed below.

MATERIAL MARKETS

This section presents brief descriptions of the markets for ferrous metals, glass, aluminum, and paper. Normally, communities sell recovered materials to the secondary materials industries rather than to primary markets, i.e., industries that actually consume the material, such as steel mills or paper plants, because most municipalities do not generate sufficient tonnages to be able to negotiate with and ship directly to consumers. Glass is an exception because most glass plants will purchase directly from generators in any quantity.

Ferrous Metal

Most scrap metal dealers will buy any clean ferrous product that can be resold to iron foundries or steel mills. Such products include junk autos, white goods, tin-free ferrous separated from mixed waste, and tin cans. Scrap prices fluctuate rapidly on a national and regional basis. Moreover, local prices depend on the amount of handling and upgrading required and on competition in the local market. The following presents a sample of the scrap metal dealers nearest to New Hanover County:

Buyer	Location	Ferrous Metal Price[2] $/Ton
Horton Iron & Metal Co.	Wilmington	15 - 25
Southern Iron & Metal Co.	Wilmington	20
Wilmington Scrap Iron & Metal Co.	Wilmington	20 - 30

For tinned steel cans with less than 5-percent contaminants by weight, a detinner may be a better market than a scrap metals dealer. A small community would sell through a dealer, however, because direct sales require a minimum shipment of one full rail car. Detinners recover the tin, which is worth more than $8 per pound, and upgrade the ferrous portion to approximate the value of a "Number 1 Dealer Bundle," a scrap grade that has averaged near $100 per ton in recent years. The major detinners, Vulcan Materials and MRI Corporation, have widely scattered facilities (e.g., Baltimore, Maryland; Tampa, Florida) are currently the closest detinning plants that would accept postconsumer tin cans. Given these long distances, shipping costs might exceed the value of the cans, which currently ranges from $25 to $35 per ton.

[2] September 1980 Prices

Glass

In recent years, glass bottle makers have recognized waste glass (cullet) as an excellent raw material. After cleaning to very exacting specifications, cullet is easier and less expensive to use than virgin materials, saves energy, and tends to increase production. Some plants use all the cullet they can get and have even installed equipment to remove metallic contaminants, such as bottle caps and neck rings; other plants are still experimenting with small quantities. Current prices for clean, color-separated cullet range from $25 to $45 per ton. Details on price and specifications can be obtained from the following glass plants:

COMPANY	LOCATION
Owens-Illinois, Inc.	Winston-Salem, N.C.
Ball Corporation	Asheville, N.C.
Indian Head, Inc.	Laurens, S.C.
Indian Head, Inc.	Henderson, N.C.

Unfortunately, none of these plants are located near New Hanover County so that prices F.O.B. shipping point will possibly be low.

Aluminum

Aluminum cans, foil, and other relatively uncontaminated aluminum scrap are readily saleable and can be economically shipped long distances because of aluminum high value per pound. Nonferrous delaers are the major market for recovered aluminum. The closest nonferrous dealers include:

DEALER	LOCATION
Horton Iron & Metal Co.	Wilmington, N.C.
Southern Iron & Metal Co.	Wilmington, N.C.

The major aluminum companies will also provide markets for aluminum scrap, either at their plants or through periodic local visits. Reynolds Metals, in Richmond, Virginia, is very active in postconsumer aluminum recycling. The current price paid for clean scrap aluminum (F.O.B. New Hanover County) is between $450 and $500 per ton.

Paper

Paperstock dealers will normally purchase all paper grades that can be extracted from the waste stream at specified levels of quality. Prices for the better grades - tabulation cards and computer printout paper--are higher and more stable than those for the lower grades, such as newsprint and corrugated. Newsprint and corrugated can be sold at "spot" prices, which reflect the current market, or via contract, with a floor price. The contract approach guarantees the community revenue from its paper, even when the market is strong. Recent prices offered by dealers (F.O.B. local community) have low ranges--$10 to $20 per ton for newspapers mixed with magazines. Clean newsprint commands a somewhat higher price that fluctuates less.

There is only one newspaper stock dealer in New Hanover County. It is Wilmington Scrap Iron & Metal Company located in Wilmington. At the present time, the City of Wilmington has a number of collection points set up throughout the City to voluntarily collect newsprint. At the present time, this is the only large scale collection effort underway.

ENERGY RECOVERY

Resource recovery technologies that can convert from 100 to 2,000 TPD of MSW to useable energy have been commercially demonstrated. This energy may take the form of RDF for firing in solid fuel boilers; low temperature steam for manufacturing processes and heating/cooling applications; high-temperature gas (air) for drying or furnace applications; and electricity.

The feasibility of recovering energy from solid waste depends on the presence of five basic ingredients:

1. Potentially viable energy buyers who could use all or most of the energy recovered from the available processible waste. These buyers typically have the technical capability to use recovered energy; rely on high-cost fuels such as natural gas or oil; operate continuously (three shifts, 5, 6, or 7 days per week); are financially healthy and viable over the long term; are located near both the available waste supply and a suitable site for a resource recovery facility; and are interested in the concept of resource recovery.

2. A sufficient tonnage of processible solid waste, from which energy and/or materials could be recovered to meet the requirements of or more potentially viable buyer.[3]

The economics of resource recovery are based primarily on energy output and revenues, so sufficient processible (combustible) waste must be available to provide adequate revenues. Because as much as 35 percent of the waste stream may be oversized or noncombustible materials, and because a portion of waste generation typically cannot be captured, care must be taken in determining the appropriate capacity for a given resource recovery system.

3. Potentially available sites that are well situated with respect to the shipment of solid waste and the delivery of energy to prospective buyers. These sites must be environmentally and physically suitable; for systems producing hot water, steam, or high-temperature gas, the site must be continguous to the energy customer. For systems producing RDF or electricity, siting is less of a constraint.

4. Resource recovery technologies that can reliably process available waste and produce energy and/or saleable materials in the form, quantity, and quality required by prospective buyers.

Because the prospective energy market will require energy con-

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[3]Processible solid waste is that tonnage which could be processed in resource recovery facility. Unprocessible materials include oversided bulky waste (e.g., large metal objects, rugs) and white goods.

tinuously, and waste transport and disposal is typically intermittent, any resource recovery system must have address reliability.

5. A total disposal cost that is competitive with the costs of alternative disposal methods available to participating communities.

Energy recovery is one of several environmentally sound solid waste management options. The economic attractiveness of resource recovery must be evaluated against the costs of other environmentally suitable disposal options.

If a preliminary feasibility study indicates the presence of these five ingredients, further feasibility work, prior to implementation of a project, is required. More specifically, the local government should:

1. Ascertain the level of interest of prospective energy customers. Perform detailed evaluations of their energy practices and requirements, including detailed energy load profiles showing hourly, daily, and seasonal variations; aggregate current and projected fuel costs; and electrical, water, and other utility charges.
2. Establish a weighing program to ascertain that sufficient solid waste is available, and perform an analysis of waste composition to ascertain that the waste has a sufficient energy value to satisfy the requirements of potential energy buyers. In addition, determine the seasonal fluctuations in waste quantity and composition.
3. Determine who controls the various portions of the waste stream and develop strategies to ensure that the waste generated can be directed to a resource recovery facility.

If these three tasks confirm the potential feasibility of the projects identified, a detailed feasibility study should be performed. Such a study

will enable the decision makers to decide whether to proceed toward resolving project implementation issues, including system performance requirements, risk management, procurement, and financing.

In considering resource recovery, it is important to be aware that:

- As much as 35 percent of the waste stream measured on a weight basis (less on a volume basis) will require ultimate landfill disposal, even if resource recovery is implemented. This waste includes oversized, bulky materials and noncombustibles, which are diverted from the project, and residues of combustion. The cost of this landfilling must be taken into account in developing the economic projections.
- The lead time for a resource recovery project is significant. For example, implementation of a modular combustion system requires a minimum of 24 months after procurement contracts are executed.
- Until recently, industry viewed recovered energy as lower in quality and less reliable than other types of energy, and expected the price of the recovered energy to be lower. This expectation is beginning to change, as industrial concerns recognize that resource recovery offers them energy self-sufficiency.

Energy Markets

As part of their Phase III evaluation of long range solid waste alternatives, PBS&J have identified nine companies as potential energy markets. They are (Reference 3):

ATC Petroleum Co.
Carolina Power & Light Co.
Diamond Shamrock
Federal Paper Board Co.
Hercofina
De Poortere
Du Pont
W. R. Grace
Union Carbide

PBS&J have eliminated ATL Petroleum, Diamond Shamrock and Union Carbide from further consideration because of unsuitable demand patterns or incompatable energy forms. The remaining six industries are being evaluated by PBS&J and the results will be published in late 1980.

APPENDIX A

COMMENTS ON PHASES II AND III

SCOPE OF WORK IN CONTRACT BETWEEN NEW HANOVER COUNTY AND POST, BUCKLEY, SCHUH AND JERNIGAN, INC.

DRAFT

COMMENTS ON PHASE II SCOPE OF WORK IN CONTRACT
BETWEEN NEW HANOVER COUNTY AND POST, BUCKLEY, SCHUH & JERNIGAN, INC.

In reviewing the Scope of Work, Phase II, of the contract between New Hanover County and Post, Buckley, Schuh & Jernigan, Inc. you may wish to consider the following comments.

1. If it is intended that the application for a permit to construct and operate at the approved site take the form of completed construction documents and if the conditions of the permit do not require changes in the documents, then Phase II may be completed with the issuance of the permit. If, however, the County expects PBS&J to amend the documents, assist in advertising, addenda preparparation, bid review, award recommendation or contract interpretation, the scope of the engineering contract should be amended or extra work by the engineer be anticipated.

2. If the county expects PBS&J to consult with and heed the counsel of Waste Management of N.C., Inc., in the preparation of short and long range construction and operation plans, the engineering contract should address the subject.

3. If a current boundary survey of the selected landfill site is available there is no need to have it repeated unless required by a financial institution.

4. The Waste Management contract refers to a permanent site acceptable to them. The PBS&J contract refers to the approved site. The county should realize this nomenclature and decide whether they want to clarify it.

5. It is unlikely that a gas collection system will be required, but if it is, it will constitute extra work under the design phase of the contract.

6. The size and construction materials for office and maintenance structures should be clarified. Some variables include permanence, operator comfort, degree of maintenance, and number and type of vehicle storage units. PBS&J and the County should decide these items before a fee is negotiated for Phase II.

7. The scope of Phase II excludes a more detailed estimate of construction cost than that made during Phase I. Such an estimate would be desirable for financial institutions, bidding advertisement, bid review and county cash flow projections.

8. Preparation of the construction documents will require knowledge of the parts to be played in site preparation by the county, Waste Management and the contractor for general construction. It should be the responsibility of the owner, before design begins, to inform PBS&J of work to be excluded from general construction.

9. The County should realize that the 5-month time allotted in Phase II for PBS&J may be needed to complete borings, topographic survey, design, applications and permit negotiations. Any plan to shorten the time requirements should include efforts by the county to expedite their decisions and those of Waste Management and the state.

DRAFT

COMMENTS ON PHASE III SCOPE OF WORK IN CONTRACT
BETWEEN NEW HANOVER COUNTY AND POST, BUCKLEY, SCHUH, JERNIGAN, INC.

In reviewing the Scope of Work, Phase III, of the contract between New Hanover County and Post, Buckley, Schuh & Jernigan, Inc. you may wish to consider the following comments.

GENERAL

In view of the present nationwide politics of solid waste it is suggested that the County Board reconsider the PBS&J contract scope. The consultants can make engineering determinations but need political guidance from the County officials. The only mentions of County activity in Phase III are in public participation and in final plan adoption. It would be well for the County to consider listing other milestones of consultant-county discussion and agreement during the planning process. It should be realized that such meetings will require more effort by the consultant.

ATTACHMENT A

1. Attachment A refers to a feasible capital financing plan, most acceptable and compatible conditions. Who will determine feasibility, most acceptability, compatibility? When will these determinations be made?

2. Attachment A - Phase III refers only to solid wastes generated within New Hanover County. Attachment B III.4, Alternative Scenarios, refers to 2 scenarios serving eastern areas of Brunswick County. This appears to be a conflict.

3. Attachment A states that the long range plan will be most environmentally acceptable and cost effective for New Hanover County.

a. Would it be equally acceptable and cost effective to nearby Brunswick County?

b. Cost effective assumes legal and agreeable in Brunswick County.

4. Attachment A mentions environmental considerations for Phase III but Attachment B doesn't mention them among 3 or 4 lists of considerations.

ATTACHMENT B

1. Attachment B, Phase III refers to disposal <u>in</u> New Hanover County that precludes disposal in Brunswick County.

ITEM III.2

1. No mention is made of the possible desire by the public to participate in resource recovery by source separation.

ITEM III.3

1. Same as above

2. Is landfilling to be considered in Phase III?

3. Three of four alternative technologies are listed with six to eight scenarios in Item III.4, leading to eighteen to thirty-two combinations. These are too many alternatives to consider in depth. How will they be screened to a reasonable number of possibilities?

ITEM III.4

1. Neither environmental factors nor public sentiment are considered as factors in rating scenarios.

2. In view of the politics of solid waste it will be fortuitous if potential energy and resource recovery markets are more than token considerations in choosing a site for even a transfer station, not to mention an incinerator.

ITEM III.5

1. When does County Board make the decision about which scenario to choose? This should be a responsibility of the owner.

2. What does Brunswick County have to say in this? This is a resonsibility of the regional group, Cape Fear COG. New Hanover County could solicit Brunswick County official opinions through the COG.

3. If perchance federal or state programs become funded, PBS&J should also consider the effect of waiting for them in the light of inflation. A few years of waiting probably negates the value of such grants and certainly obliterates the value of loans.

4. Is the County interested in private ownership of disposal process? This is not addressed.

ITEM III.6

1. The County has been conducting the public hearings in Phase I. Who will conduct them in Phase III?

2. It is suggested that the County redefine "public workshops/ public participation" in the light of the past two experiences. The contract descriptions don't match the T.V. and newspaper analyses which referred to them as "hearings" or "meetings."

APPENDIX B

REFERENCE DATA

TABLE B.1

DESIGN/OPERATING VARIABLES FOR EXISTING AND PROPOSED SOLID WASTE DISPOSAL FACILITIES

Source: Reference 11

DESIGN/OPERATING VARIABLES	EXISTING FACILITIES	PROPOSED DESIGN BASIS
1. Landfill liner	None	See Figure 3.1
2. Availability of clay material	N/A	On Site
3. Security	None	6ft fence around active site
4. Groundwater monitoring	None	2 observation wells
5. Leachate Collection	None	See Figures 3.3 and 3.4
6. Leachate Treatment	None	ph Adjustment and physical-chemical treatment
7. Closure	None	See Figure 3.1
8. Interest Rate	10.9-11.7%	10.9-11.7%
9. Land Cost	$1,000-$15,000 per acre	$1,000-$15,000 per acre

TABLE B.2

TRANSFER STATION COST MODEL

Source: Reference 12

The following is a description of the cost model used to develop the information in Figure 4.2. The data presented below is hypothetical and illustrates a method for evaluating costs of transporting waste to a disposal site. For the transfer rig, the haul cost is imposed on the cost of transfer operations (see Figure 4.2). A cost for transfer of $4.00 per ton has been assumed. Ultimately the curve for the transfer rig plus the transfer station will intercept the steeper curve for the collection packer truck. The point of interception, when projected downward, will show the round-trip time at which a transfer operation is justified. The data used to derive this graph is presented below, solely for the purpose of demonstrating the method.

TRANSPORTATION COSTS PER VEHICLE	COLLECTION TRUCK	TRANSFER TRAILER
Time-based costs per year		
Vehicle amortization[1]	$ 5,260	$ 9,468
Driver's salary, fringe benefits[2]	10,625	12,500
Collector's salary, fringe benefits[2]	9,375	0
Vehicle insurance, licenses, taxes	1,500	2,500
Subtotal	26,760	24,468
Subtotal per minute[3]	$ 0.214	$ 0.196
Mileage-based costs per mile		
Fuel,$ oil, tires[4]	0.080	0.150
Maintenance and repair	0.050	0.050
Subtotal	0.130	0.200
Subtotal per minute[5]	0.087	0.107
Total per minute	0.301	0.303
Total per ton per minute	0.060	0.015

1 Diesel compactor truck ($25,000) with a 5-ton payload capacity and diesel tractor trailer ($45,000) with 20-ton payload capacity amortized over 6 years at 8 percent per annum.

2 Fringe benefits approximated as 25 percent of salaries (collection truck driver, $8,500; collector, $7,500; transfer trailer driver, $10,000).

3 Assumed 5-day workweek, 8-hour workday.

4 Fuel costs dependent upon price (e.g., 30 cents per gallon) and consumption (e.g., 6 miles per gallon).

5 Round-trip transport, 40 miles; round-trip transport time, 60 minutes for collection truck, 75 minutes for transfer trailer.

The cost for operating the transfer trailer and collection trucks is expressed in terms of dollars per ton per minute. These units were selected since they represent the slope of the transfer trailer and collection truck cost lines shown in Figure 4.2.

APPENDIX C

REFERENCES

REFERENCES

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